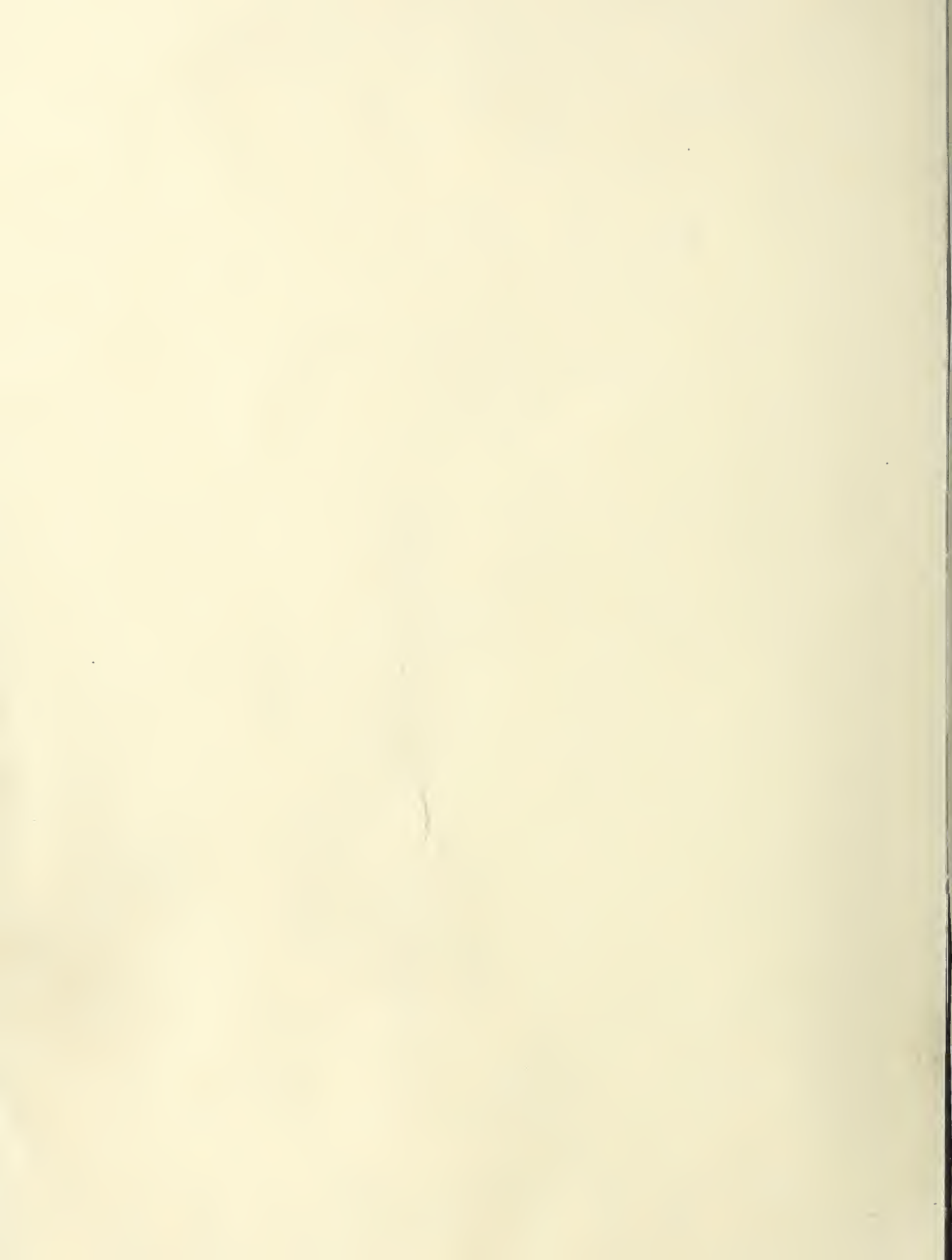


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# NATIONAL BUREAU OF STANDARDS REPORT

10 216

## HEALTH AND SAFETY GUIDE CRITERIA

from

NBS Guide Criteria for the  
Design and Evaluation of  
OPERATION BREAKTHROUGH  
Housing Systems

sponsored by

DEPARTMENT OF HOUSING  
AND URBAN DEVELOPMENT



U.S. DEPARTMENT OF COMMERCE  
NATIONAL BUREAU OF STANDARDS

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## HEAT AND SAFETY GUIDE CRITERIA

from

NBS Guide Criteria for the  
Design and Evaluation of  
OPERATION BREAKTHROUGH  
Housing Systems

by

The Building Research Division Team  
E. O. Pfrang, Manager

sponsored by

DEPARTMENT OF HOUSING  
AND URBAN DEVELOPMENT

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## HEALTH AND SAFETY GUIDE CRITERIA

from

NBS Guide Criteria for the  
Design and Evaluation of  
OPERATION BREAKTHROUGH  
Housing Systems

### ABSTRACT

The sources of accidents in residential occupancies were investigated, and certain requirements to eliminate or mitigate the effect of causes pertinent to the building, its parts, or equipment were developed for the NBS Guide Criteria for the Design and Evaluation of OPERATION BREAKTHROUGH Housing Systems (NBS Report 10200).

In an appendix, the home accident statistics indicated in a Department of Housing and Urban Development contract report, "Home Accident Causes and Recommended Remedial Measures," were related to the health and safety criteria.





## INTRODUCTION

The building construction Guide Criteria developed by the National Bureau of Standards for the Department of Housing and Urban Development Operation Breakthrough provide a certain minimum level of safety for residential occupancies. The principal safety requirements now imposed on housing by regulatory codes specify a measure of fire containment, structural stability, and means of emergency exit. In addition to suggesting requirements in these areas, the Operation Breakthrough Guide Criteria from their inception have included such features of construction as to assure to the extent possible that the building and its parts shall not be the cause of accidents to the occupants.

As a basis and indication of the need for regulation in this area, a study was made of home accident statistics compiled by the National Safety Council (Accident Facts) and the Public Health Service (U. S. National Health Survey, Persons Injured in the Home, Health Statistics Ser. B-39). The need is apparent, as accidents in the home result in approximately 29,000 fatalities annually and a single year injury rate of 4 to 21 million, as determined by the respective definition of "injury" by the National Safety Council or the Public Health Service.

In providing safety from the various possible hazards, difficulty arises from the fact that accidents in the home, as elsewhere, are often the result of the actions of the victim, or may not be attributable to any required feature of the building. But as it appeared that certain elements of a structure could present hazards to those in the building, design requirements have been included in the Guide Criteria for these elements insofar as they are amenable to regulation.

To illustrate the extent of the concern of the criteria in the fields of safety other than those generally included in building regulations, there is presented here a review of excerpted Guide Criteria covering home accidents hazards.

Also, because of its relevance as a potential source of harm, certain requirements designed to reduce the possibility of criminal activity were inserted in the Guide Criteria, and are included in this review. Attention has been given to the requirements peculiar to the provision of safety and convenience in housing intended for the elderly and those with limited handicaps. Criteria to meet these requirements have been proposed for inclusion in the Guide Criteria, and are also reviewed here.

Although the Health and Safety Guide Criteria include mention of requirements to cover fire hazards as well as for mechanical equipment and lighting, extensive criteria in these areas are developed in other sections of the Criteria, and generally are not elaborated upon in this review. In this connection, it is notable that the criteria developed by the National Bureau of Standards, by incorporating certain requirements for flame spread, smoke production and potential heat release of building components and materials as well as for smoke detectors in certain occupancies, provide a greater measure of life safety than do many of the model or regulatory building codes.

In the presentation here, there is a description of the hazard followed by the appropriately numbered excerpt from the Guide Criteria. The requirements for Operation Breakthrough were designed to cover the following categories of residential buildings:

|                        |        |
|------------------------|--------|
| Multifamily High Rise  | (MFHR) |
| Multifamily Low Rise   | (MFLR) |
| Single Family Attached | (SFA)  |
| Single Family Detached | (SFD)  |

The criteria included in this review are applicable to all four of the building categories, unless a more restricted application is indicated by the inclusion of one or more of the building category abbreviations after the criterion number.

## Falls

Falls are the major cause of home accident casualties, accounting for about 40 percent of the fatalities. Because of its importance, elements that might be the cause of falls are dealt with extensively in a number of criteria.

It is recognized that it is not now practicable in all circumstances to provide floor surfacing materials which satisfy the acceptable slipperiness level under wet conditions. In such cases, good design would provide railings or hand holds in certain wettable areas, especially if sloping, such as on ramps and in bathtubs and showers.

Design (limiting the height of shelves and cabinets, and providing lighting facilities at lower than ceiling level wherever practicable) also can be employed as a means of minimizing the number of falls as a result of standing on ladders and other objects to extend vertical reach.

The material excerpted from the Guide Criteria, including the general criterion below and the more specific criteria following, are applicable to all four of the categories of construction, except where the inclusion of one or more construction type designations after the criterion number indicates a restricted application.

### ■ Criterion L.3.1.1

- (a) Elements providing the causes of falls either on the same level or from one level to another should be eliminated or minimized.

### ■ Criterion L.3.2.1

#### (a) Slipperiness

1. To prevent slipping, walking or standing surfaces should have a British Portable Tester Number greater than 35 when measured in dry condition.
2. Abrupt changes in slipperiness should be avoided within practicable limits (but not forbidding carpeted surfaces adjoining smooth floor surfaces meeting the requirement of L.3.2.1(a)1).

3. To the extent possible, floor surface materials, the slipperiness of which shows marked increase with wetting, should not be used in areas subject to wetting.

(b) Falls, General

1. Excessively rough surfaces, protrusions (vertical or horizontal), sills, and carpet weaves that may cause falls by tripping should be avoided.

2. Small changes in floor level are not permitted, except by ramps; there should be a minimum number of three steps in any stairs.

3. Stairs, landings, open balconies, and roof decks accessible to the occupants, where not protected by walls, should be provided with suitable rails or enclosures to prevent occupants or objects falling from them by passing over, under or through; guard rails should be 48 inches minimum in height. Hand rails on stairs should be 30 to 33 inches high (measured from tread nosing). Guard rails should be designed to withstand a horizontal thrust of 50 pounds per lineal foot applied at the top of the rail.

4. Openable windows should not require excessive force to open and should have sills sufficiently high to prevent falling through, or be protected with guards or rails; exterior surfaces of such windows should be safely washable by residents without use of special equipment not ordinarily available to them.

5. Safe means of egress should be provided for the evacuation of the building occupants in an emergency.

■ Criterion L.4.2.5 (MFHR: MFLR)

Exterior Balconies -- May be used as a means of exit. If used as exits, balconies:

(a) Must have weather enclosed stairways at either end; stairways must meet requirements for interior stairs.

(b) May have no dead ends.

(c) Top most balcony must be roofed.

(d) The open side enclosure of balcony should not exceed 50 percent. Guardrails on open sides shall be 48 inches high minimum and shall have adequate kickplates.

■ Criterion L.4.2.5 (MFHR: MFLR)

Stairs

Minimum width of stairs should be 44 inches.

Maximum height of stair risers should be 8 inches; stair treads should be 9 inches minimum plus 1-1/2 inch nosing; total of two riser heights plus one tread width shall be 24-25 inches.

The minimum headroom on stairs should be 6 feet 8 inches; maximum height between landings should be 12 feet; least dimension of a stair landing should be not less than the required width of the stairs; winders not permitted; minimum number of steps between landings is three; required protection of stairwell enclosure should be 2 hours, noncombustible.

Handrails should be provided on each side of stairways; intermediate rails should be provided in stairways over 66 inches wide. Handrails should be not less than 30 inches nor more than 33 inches high (over tread nosing); should not project into walkway more than 3-1/2 inches; should have ends returned to enclosure walls or posts.

■ Criterion L.9.9.3

Private stairways should be designed and constructed to meet the requirements of public stairways except for the following items:

(a) Main Stairs: Width clear of handrail - 2 feet 8 inches; Run - 9 inches plus nosing; Balanced winders - acceptable provided the run at a point 18 inches from converging end is not less than the run of the straight portion of the stair.

(b) Service Stairs: Width clear of handrail - 2 feet 6 inches; Headroom 6 feet 4 inches; Riser height - 8-1/4 inches; Run - 9 inches, plus nosing for either open or closed; Winders - (same as for main stairs); Landing - not less than 2 feet 6 inches square.



## Fires

Casualties from accidental fires in the home include over 6,000 deaths a year, or more than one-fifth the total of all home accident fatalities. Requirements designed to improve the fire safety of residential buildings are included in the various sections of the Guide Criteria dealing with the several structural elements of a building, the building equipment, and the exiting facilities. Pertinent requirements for some of the last have been included in this review under the immediately foregoing section on fall hazards.

### ■ Criterion L.3.1.1 (MFHR: MFLR)

(b) The causes of casualties from fires should be reduced, according to the requirements of this standard; suitable warning systems for fire and means of safe exit, allowing evacuation of the endangered area before it becomes untenable should be provided. (See L.4, and Sections .4 of other chapters.)

### ■ Criterion L.3.1.1 (SFA: SFD)

(b) The causes of casualties from fires should be reduced, according to the requirements of this standard; suitable means of safe exit, allowing evacuation of the endangered area before it becomes untenable should be provided. (See L.4, and Sections .4 of other chapters.)

Malfunctioning of heating and cooking equipment can be a cause of fires, and also of nonfire fatalities by carbon monoxide poisoning - some 300 deaths were attributed to defective home heating equipment in a recent year. There is a particular danger from fires, asphyxiation or gas poisoning in the use of temporary or makeshift heat producing means.

### ■ Criterion L.3.1.1

(c) Heating and cooking equipment should not present the hazard of burns from excessively hot surfaces outside the immediate heating area, or carbon monoxide poisoning due to incomplete combustion or other malfunction, and should be provided with sufficient capacity, based on the occupancy, to

obviate the necessity for improvised or temporary facilities which can present fire, explosion or burn hazards.

### Sharp Edges

Sharp points and edges on building elements and equipment can be the cause of numerous although usually minor accidents. The hazard can be reduced or eliminated by proper design or selection. A number of injuries and some deaths have been caused by shattering of glass doors on human impact. The use of nonshattering materials should eliminate this hazard, but leave the danger of bumping into invisible surfaces - hence the requirement there be some indication of the glass presence.

#### ■ Criterion L.3.1.1

(d) Structural elements or installed equipment or furnishings should to the extent practicable, be free of sharp edges and sharp or pointed projections; invisible, transparent surfaces should not be placed in a line of travel unless some indication of their presence is provided; transparent materials in doorways and bath or shower enclosures should be shatter-resistant plastic, or wired, tempered or laminated glass, or equivalent material not presenting the hazard of shattering on impact.



### Confined Spaces

A small number of cases of death of children by suffocation in confined spaces have occurred. Household refrigerator doors are already the subject of federal legislation. Doors to cabinets and other storage spaces usually present no problem, or can be easily so designed. Bifold or easily sliding doors on closets can eliminate latch problems.

#### ■ Criterion L.3.1.1

(e) All enclosed spaces provided as part of the structure or in installed equipment, if of such size as to contain a small child, should be readily and easily openable from the inside.

### Other Safeguards

Some fatalities and a number of injuries occur from blows by falling objects. The intent of the criterion is to eliminate the possibility of equipment or furnishings falling on the occupants, or spilling their contents on them.

#### ■ Criterion L.3.1.1

(f) Built-in structures, equipment or furnishings, or those supplied with the residential unit or building should be so constructed and secured as to preclude the possibility of their falling or toppling under normal conditions of use.

The following two criteria are included as safeguards for the health and well-being of the occupants. They are in addition to requirements of similar purpose in other sections of the Guide Criteria covering sanitary facilities, heating, etc.

#### ■ Criterion L.3.1.1

(g) The building should be so constructed as to prevent the ingress of insects, vermin, and rodents.

(h) Floor surfacing should be cleanable, not subject to attack by mildew or other fungus, and should not endanger health or cause obnoxious odors.

Adequate lighting can make visible, and thereby given attention or avoided, some of the elements causing falls; also, can act as a deterrent to criminal activity (see below).

#### ■ Criterion L.3.1.1

(j) Sufficient lighting facilities should be installed to provide night-time safety to the degree contemplated for daylight hours.

Obstructions in a line of travel can cause impact accidents, and may also impede exiting in an emergency.

■ Criterion L.3.1.1

(k) Awnings or hoods should not project onto a passageway so as to impede movement.

## Security

The necessity for security from criminal acts is the basis for the insertion of the following requirement in the Guide Criteria:

### ■ Requirement L.3.3

To the extent possible, the building should be designed and equipped to provide the maximum possible security from criminal actions to the permanent and transient occupants thereof, and to their possessions.

In considering the possibilities and problems of safeguarding the occupants in both multifamily and singlefamily buildings, the Guide Criteria contains the following:

### ■ Commentary on L.3.3.1

Positive security from criminal activities is impossible to attain, although the requirements in the criteria specified herein, if implemented, will alleviate to a considerable extent the impact of a problem which rightfully has its solution outside the premises.

In addition to the items specified, there are certain other solutions which have not been listed under the criterion, either because their use would present serious problems in areas other than their contemplated utility, or because of their elaborate or sophisticated (by present practice) characteristics. Principal among the former are bars or grilles on lower-story windows, which while preventing entrance of criminals, will certainly impede escape in a fire emergency. Building codes have generally required that windows be openable as a means of escape in buildings of construction types having low fire resistance.

Systems of closed-circuit television monitoring are available. These can be installed at entrances and in corridors and public spaces. Similarly, continuously operating audible systems may be employed. Both of these, however, require constant monitoring, and even in the largest buildings such systems of surveillance have been considered prohibitively expensive. New developments may make these systems less elaborate, and thus more feasible financially. Also, other means of protection and surveillance may be devised, and

consideration of these should be such as to encourage and foster their development and use.

To implement the intent of the requirement for security from criminal acts, the following criteria have been developed. These are applicable in their entirety to multifamily high rise buildings, and also to multifamily low rise, except where certain features, such as elevators, may be basically not required.

■ Criterion L.3.3.1 (MFHR: MFLR)

(a) Unattended entrances, including rear, service, garage-to-exterior, and garage-to-building should be self-closing and self-locking; unattended main entrance should have voice communication to each apartment, and a means for releasing entrance door latch from each apartment.

(b) Entrance doors to living units should be solid, without glass openings and should be capable of resisting forcible entry; building entrance doors (other than main) should be solid, or if provided with glassed openings, should have wire or grilles to prevent operation of the door latch from outside by hand or instrument; main entrance doors may be non-shattering glass.

(c) Dead locks, openable without key from the inside, should be provided on all living unit entrance doors.

(d) All exit doors should be openable from the interior without use of keys.

(e) Doors to storage, maintenance and building service rooms should be self-closing and self-locking.

(f) Living unit-to-corridor doors should have a visitor-observation port for the use of the tenants.

(g) Passenger elevators should have mirrors so placed as to make visible the whole of the elevator interior to prospective passengers outside the elevator; mirrors should be framed and mounted to minimize the possibility of their accidental falling or shattering.

(h) Elevator emergency stop button should activate the elevator alarm.

(i) Corners where corridors change direction, and concealed or partially concealed areas in public spaces should have mirrors so mounted as to show the nonvisible portion.

For practical reasons, the criteria covering the requirement for single-family dwellings were limited to the following:

■ Criterion L.3.3.1 (SFA: SFD)

(a) Entrance doors to living units should be substantial enough to deter forcible entry.

(b) Dead locks, openable without key from the inside, should be provided on all living unit entrance doors.

(c) All exit doors should be openable from the interior without use of keys.

## Housing for the Elderly

Special safety criteria pertaining to the problems of housing the elderly have been developed and proposed for inclusion in the Operation BREAKTHROUGH Guide Criteria. The purpose of the criteria is to make it possible for persons having the handicaps of age and/or limited disability to live by themselves without the necessity of outside physical assistance for the greatest possible time. The usual condition of the elderly and handicapped is that both their capabilities and financial resources may be limited. Thus their space requirements are small, and will be provided most economically in apartment buildings. In accordance with the Operation BREAKTHROUGH aim of encouraging the use of innovative methods leading to the mass production of housing, the criteria set forth in this part are designed to allow the use of basic units proposed for Operation BREAKTHROUGH housing with relatively minor or superficial modification.

The general requirement is presented here, with the several criteria intended for its implementation following:

### ■ Requirement L.3.4

Housing proposed specifically for occupancy by the elderly and certain others with limited handicaps should meet the intent of the following criteria in addition to all the other safety criteria for the guidance of the design of housing for Operation BREAKTHROUGH.

#### ■ Criterion L.3.4.1

Living units designed for easy maintainability should be provided, to consist of kitchen, bath and one room (living, dining, bed), or two rooms (separate bedroom), with adequate closet and storage space.

#### ■ Criterion L.3.4.2

Occupant should not have to make use of steps either to reach his living unit, or for movement within the unit (thus ground floor units only in buildings without elevators).



■ Criterion L.3.4.3

The numbers of exterior entrance steps should be kept to a minimum; ramps are preferable and should be provided if possible; if steps are necessary, hand rails, and a top landing large enough for safe and convenient standing with the door in open position should be provided.

■ Criterion L.3.4.4

Outside entrance doors should be easily operable by frail residents; provision of power-operated doors (capable of manual operation if power mechanism is inoperative) is desirable; where high winds may prevail, entrance should be by either of two facing doors normal to the building front wall (not applicable to power-operated doors).

■ Criterion L.3.4.5

For fire safety, all of the criteria proposed for Operation BREAKTHROUGH housing in general should be maintained. (Special case for Volume II, Low Rise Multifamily or garden type units, no elevator: each living unit, in addition to being on the ground floor, should be provided with an outside entrance).

■ Criterion L.3.4.6

Lighting of corridors and other public spaces should be of greater intensity than that ordinarily provided in residential occupancies; similarly, fire alarm signals should be extra loud, and of a type not readily confused with prevailing background noises.

■ Criterion L.3.4.7

Corridors should have railings at sides, at a height of 30 to 33 inches above the floor, and projecting from the wall a sufficient distance for ease in grasping, but not more than 3-1/2 inches.



■ Criterion L.3.4.8

Self-closing doors to living units, at building entrance and on elevators should have slow moving or delayed action closers; cabinet doors should not be self-closing.

■ Criterion L.3.4.9

Bathrooms should be equipped with grab bars (to withstand a 250-lb. pull) at tub and watercloset; tub should have built-in seat and facility for a hand spray.

■ Criterion L.3.4.10

Means should be provided to regulate the temperature of hot water delivered at kitchen and bathroom faucets to not exceed 120°F.

■ Criterion L.3.4.11

Door and faucet knobs should be designed to facilitate their turning by those with a weak grip.

■ Criterion L.3.4.12

Closet doors should preferably be sliding or bifold; no means of locking should be provided on any living unit interior door.

■ Criterion L.3.4.13

Shelves in cabinets and closets should be at a level and of a depth not requiring the use of height extenders such as ladders, stools or chairs; (if standard cabinets are provided, the area of shelves reachable without aid should be sufficient for the occupant's needs). In providing storage space, consideration should be given to the reduction in reach caused by the protrusion of counters or fixtures beneath the space.

■ Criterion L.3.4.14

The provision of storage space over cooking ranges should be avoided; eye-level oven doors should be side opening (side hinged or sliding) rather than drop opening.

■ Criterion L.3.4.15

Ceiling light fixtures should be of the pull-down type to facilitate cleaning and the changing of bulbs.

## APPENDIX

Subsequent to the initial preparation of the Operation BREAKTHROUGH Guide Criteria, including the sections on health and safety, the Department of Housing and Urban Development made available a contract report, Home Accident Causes, etc. A comparison of the accident hazard statistics shown in the tables of this report with the requirements of the Health and Safety Guide Criteria indicates that within the limitations of current practice and state of the art, Operation BREAKTHROUGH requirements are designed to eliminate or mitigate the effect of the reported accident causes, as well as some others.

To show the extent home accident causes as listed in the HUD report were recognized in the Guide Criteria, the following outline presents the reported cause of accidents (with notation of table), followed by a brief mention of Guide Criteria requirements applicable to this cause, and the Guide Criteria numbers of material in this review, if the complete wording of a criterion is required.

(Table 3) Stair Accidents

1. Slippery tread - Guide Criteria for maximum slipperiness of floor surfaces L.3.2.1(a)1
2. Steep Stairs, narrow tread - stair dimensions specified within narrow limits L.4.2.6 and L.9.9.3
3. Handrail missing - handrails required L.4.2.6

(Table 8) Tub and Shower Accidents

1. Slippery surface - slip reducing surfaces are required in the criteria L.3.2.1(a)3 and 4
2. Handholds and grab-bars - installation suggested for general housing; required in proposed criteria for housing for the elderly L.3.4.9

(Table 9) Glass Door Accidents

1. Type of glass - specified to be shatter-resistant plastic, or wired, tempered or laminated glass, etc. L.3.1.1(d)
2. Absence of markings on clear glass - indication of presence of transparent materials required L.3.1.1(d)

(Table 12) Windows

1. Extreme pressure to open - required not to be excessive L.3.2.1(b)4
2. Risky to clean - required to be safely washable without special equipment L.3.2.1(b)4
3. Low Window Sills - height to prevent falling through required L.3.2.1(b)4
4. Sharp edges - generally prohibited in building L.3.1.1(d)

(Hazard from windows not secure when open probably not a problem in windows of modern design; awkward position of window will probably be precluded by the requirement that window be safely cleanable; safety glass has not been required in windows, and the problem of glass shattering does not appear to be great enough to warrant the expense of its installation.)

(Table 15) Doors Other than Glass

1. Normally closed left open - doors to living units required to be self-closing L.4.1.1
2. Sharp door frame - sharp edges prohibited L.3.1.1(d)

(Table 18) Hot Water System Burns

1. Leaky faucets - no requirement; mainly a maintenance problem; some single-lever faucets are claimed to have long valve life - available for kitchen sinks, may consider requirement.
2. Differential pressure - no requirement, but under consideration; existing standards referenced H.3.3.1 and H.3.4.1
3. Temperature setting on water heater - maximum temperature setting specified for housing for elderly L.3.4.10

(Table 21) Electrical Outlet Accidents

1. Metal object stuck in outlet - criteria requirements are in accordance with National Electrical Code, which makes no provision for closed or covered outlets; although available outlets with such safety features can probably be defeated by an enterprising and determined child, investigation is being made of their utility and the possibility of their requirement in the criteria. Consideration should be given to the fact that certain types of outlets intended to provide safety against tampering, may instead act as an "attractive nuisance." National Safety Council statistics indicate that while this outlet hazard may be the cause of injuries, there is almost no record of fatalities.

(Table 23) Kitchen Cabinet Accidents

1. Normally closed door left open - not practical to have self-closing doors; accidents occurring from doors left open should be classified as due to the action of the victim (or other occupant).
2. Cabinet too low - does not appear to be a hazard, unless bumped heads or back injuries occur from stooping or bending - not really attributable to fixture.
3. Sharp counter edges - covered in a general requirement L.3.1.1(d)
4. Improperly secured - requirement for securing fixtures L.3.1.1(f)



